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MODERNIZATION OF GRINDING MACHINES

Modern Requirements

Modern machine-building technology is emphasizing more and more the need for making grinding machines automatic and for building new automatic and semi-automatic production and high-precision machine tools. In addition, the constantly increasing use of automatic transfer machine lines is making more acute the need for including grinding operations in the automatic lines.

This trend toward making grinding machines automatic brings with it a number of complex problems such as the automatic checking of sizes and shapes of workpieces, with automatic control of machine operation; increasing the speed of grinding; and fast, high-quality diamondless truing of grinding wheels in the automatic cycle.

Requirements for precision and finish in the machining of parts have increased steadily, as has the relative proportion of heat-treated parts in machines. Allowances for machining have been decreased continuously by the use of precision forming, casting, and pressing. As a result, the proportional amount of grinding operations and types of grinding machines will have to increase.

Grinding Lags Behind Cutting

Modernization of abrasive tools has lagged behind the modernization of cutting tools. For example, during the past 15 years the speed of turning has increased 10 or more times, whereas the speed of grinding has not increased more than $1\frac{1}{2}$ times.

There is reason to believe that in the near future the quantity and number of types of high-speed grinding disks will be increased, and high-speed methods of grinding will find wide application in Soviet industry.

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The increase in productivity of general purpose grinders is achieved mainly by making them automatic and cutting the time required for auxiliary operations. Productivity in large-scale series and in mass production is being raised along the following lines:

1. By development of grinders which have several simultaneously operating wheels with individual controls.

2. By development of grinders which operate simultaneously with several wheels on a single spindle.

3. By increasing the width of grinding wheels.

4. By the development of grinders for machining several parts simultaneously with one wheel.

5. By extensive automatization of the grinding processes.

A wider disk increases productivity considerably when grinding parts with a longitudinal feed, since it removes more metal per pass and decreases the number of passes. With a traverse feed, a wider disk makes possible the grinding of long multistep shafts with the simultaneous machining of several steps or several parts, as well as the grinding of nonrigid parts of small diameter and long length which are very difficult to machine on a center machine.

Multispindle Grinders

A cylindrical grinder with several grinding spindles has certain advantages over machine tools with several grinding wheels on one spindle. The basic advantage is in the independent control of each disk. Upon reaching size, the movement of the disk can be stopped independently from the other grinding wheels. In addition, it is possible to build machine tools on the basis of automatic grinding units which will accomplish all necessary movements of the grinding wheel as well as its truing. The basic shortcoming of this machine tool is that the number of grinding wheels which can be used is limited. It is usually difficult to use more than three grinding spindles.

Thread-grinding machines have been provided with special devices which compensate for gaps in the kinematic chain between the lead screw and the spindle.

To reduce axial displacement of the disk, or the center of the headstock when the temperature of the spindle varies, the spindle bearings for the grinding disk should be placed near the disk, while the spindle bearings of the part are placed closer to the front end of this spindle.

As a precaution against vibration, electric motors are installed on rubber cushions and shock absorbers and a precision dynamic balancer is used for all rapidly rotating parts.

It is important to note that the weakest elements in regard to rigidity in cylindrical grinding machines lie in the tailstock; in internal grinders, in the grinding wheel spindle; and in surface grinders which operate with the periphery of the disk, in the grinding heads. These elements require an absolute increase in rigidity.

Trends in Bearing Design

For the most part, sliding friction bearings are used in the main spindle units of cylindrical and surface-grinding machines. The bearings insure a higher finish of the surface being ground. The main responsibility of designers in designing bearings of this type is to insure minimum displacement of center of spindle rotation under alternating loads and alternating heat conditions in bearing operation.

Two basic trends in the design of spindle bearings have arisen:

1. The manufacture of bearings which operate with small clearances through the use of lubricant mixtures having an extremely low viscosity (kerosene + 10 ÷ 15 percent of mineral oil of low viscosity). Three oil wedges assure liquid friction and maintain constant pressure.

2. Maintaining high accuracy and steadiness of spindle rotation regardless of load change or heat conditions by (a) the use of self-adjusting shoes which assure the creation of oil wedges having extremely high hydraulic pressure, as a result of which the spindle is centered and assumes a steady position; (b) by automatically adjusting clearance under changes of heat and lubricant viscosity; and (c) by an abundant inflow of lubricant for continuous maintenance of oil wedges and intensive heat deflection. Under these conditions it is possible to use a lubricant of high viscosity, since the proper angle of the oil wedge is set up automatically.

Another important trend is the introduction of electronic-ionic regulators for stepless changing of speeds in the unit which drives the work piece on cylindrical or thread grinders. Only a small amount of power is required for such a regulator, usually not exceeding one horsepower. The electronic-ionic units are compact and have comparatively simple circuits.

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